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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XXI.

THE NORFOLK SAND.

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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XXI.

THE NORFOLK SAND.

GEOGRAPHICAL DISTRIBUTION.

The Norfolk sand is the most widely distributed sand soil in the Atlantic and Gulf Coastal Plains regions. It is found in every State from New Jersey, in the North Atlantic Division, southward to Florida, and thence westward along the Gulf coast to Texas. The Norfolk sand has been encountered in 55 areas in 12 different States and has been mapped in these areas by the Bureau of Soils to the extent of 2,542,412 acres. Since these soil surveys cover only about 14 per cent of the entire area of the Coastal Plain region within which they have been made, it is easy to calculate that the extent of the Norfolk sand in these 12 States must aggregate many millions of acres. If complete soil surveys had been made of the entire coastal section it would doubtless be found that the Norfolk sand occupies an area of between 17,000,000 and 20,000,000 acres.

The Norfolk sand is found principally in the lower-lying areas, ranging about 100 miles back from the coast. It is not found in the prairie region of Texas, Alabama, and Mississippi. It is not usually found to any extent along the inland margins of the Coastal Plain, but rather from the actual shore line inland to varying distances, depending upon the local topography and upon the character of marine deposition which has given rise to this and associated soil types.

CHARACTERISTICS OF SOIL AND SUBSOIL.

The characteristic appearance and properties of the Norfolk sand are remarkably uniform when the wide extent of territory within which it is found and the divergent circumstances under which different portions of the type have been brought under cultivation are considered. Typically the Norfolk sand to an average depth of about 6 inches is a gray sand of medium texture. The color of the surface soil frequently varies somewhat, even within the limits of the same field. The higher lying and more completely drained areas will be light gray to nearly white in color, while depressions

within the field will usually tend toward a brown or a dark-gray color. This difference in coloration of the same material arises chiefly from slight differences in the amount of organic matter present and represents variations in the condition of its decomposition. Where drainage has been most complete and the soil has been most perfectly aerated, there is a tendency toward the destruction of organic matter in the loose, incoherent surface soil and a resultant tendency toward the lighter gray or nearly white color. In the lower lying areas, where there is a greater amount of moisture and where complete decomposition of organic matter is not the general rule, the colors become gradually darker with increasing humidity in the surface soil, until a brown, somewhat loamy covering is formed at the surface of the soil, showing its gradation toward other swampy and lower lying types.

The subsoil to a depth of 36 inches or more is typically a medium to somewhat coarse, incoherent yellow sand. In small areas where the Norfolk sand occurs in connection with other types the deeper subsoil is often modified in color from the usual pale yellow to orange, red, or even mottled yellow and red. Such variations in the color frequently occur where the Norfolk sand is found in small patches and in close association with types of the other series. They usually mark a thin development of the Norfolk sand associated with soils of the Orangeburg or Sassafras series. Even in localities where the Norfolk sand is typically developed to a considerable extent it is not unusual to find near the margins of each of the areas of this type locations where borings at the greater depths show sandy yellow clay, or yellow friable clay, which characterize such types as the Norfolk sandy loam and the Norfolk fine sandy loam. These constitute the gradation into another type of the same series.

A characteristic difference between the Norfolk sand and other sandy soils of the Coastal Plain is a yellow subsoil to the complete depth of 36 inches. In the case of the Sassafras and the Orangeburg sand, respectively, the subsoil is either orange sand or orange loamy sand grading into red sandy clay. Thus the Norfolk sand is easily distinguished from all other soils of similar texture within the region in which it occurs.

SURFACE FEATURES AND DRAINAGE.

The surface topography of the Norfolk sand varies to some degree in the different areas within which it is found. In general the surface is level to slightly undulating, with no steep slopes and no pronounced stream channels or drainage ways within the area of the type itself. It is so easily permeated by atmospheric water that no large amount of erosion occurs, and consequently no pronounced topographic relief is formed. It is somewhat subject to movement by the

stronger winds in areas where it is not completely covered by forest, and as a result low hillocks and rounded ridges of sand, quiescent dunes, may be found in certain portions of the type along the inland margin of the Coastal Plain areas or directly along the seacoast, where such wind movement is continually tending to pile up all loose and incoherent materials. Small areas of the Norfolk sand are sometimes found along the steeper slopes which bound the main drainage ways of the tidewater section of the Coastal Plain. These have been formed by the outcropping of underlying sandy materials exposed at the surface by erosion. With these exceptions the surface features of the Norfolk sand are so nearly level that cultivation of all portions of the type is easy.

The surface of the Norfolk sand lies at heights ranging from sea level to 400' or 500 feet. It is probable that by far the greater proportion of the entire area of the type is to be found at altitudes of from 25 to 250 feet. These areas constitute the portion of the type most extensively cultivated. Among them the flat, slightly elevated sections on the "river necks" in the estuarine portion of the North and Middle Atlantic coasts have been most generally occupied for the special purpose crops to which the Norfolk sand is usually devoted. The predominance of such areas near tide-water transportation, usually in locations which are climatically favored by the presence of large bodies of water, has given the Norfolk sand an unusual value for the production of special crops.

Owing to the rather loose and incoherent texture of the Norfolk sand, to the prevailing absence of any large amount of organic matter in either the surface soil or subsoil, and to its topographic position within a region intersected by many large streams, the type is unusually well drained. In fact it may be characterized throughout as excessively drained for the production of general farm crops. These features make the Norfolk sand preferable for growing special crops rather than for general farming.

Water erosion is not a marked feature of the different areas of the Norfolk sand. Wind erosion in some instances interferes with the cultivation and production of certain special crops. In the case of an incoherent friable soil of this character, which is easily dried out after each summer shower, the surface material becomes powdery and lacks coherence. As a result strong winds blowing from the coast country inland frequently pile up the cultivated surface soil along the crop rows, interfering seriously with their growth or totally smothering out low-growing plants. It is possible easily to counteract this tendency through methods of cultivation, and particularly through the incorporation of large amounts of organic matter in the soil. Similarly, apparently at some previous stage of its existence, considerable tracts of the inland portion of the Nor-

folk sand have been piled into ancient sand dunes, which are no longer moving, except over small local areas. Dunes of this character are generally located near the inner border of the different regions where the Norfolk sand is developed, and they mark a gradation from the level or gently rolling tide-water section of the Coastal Plain into the "sand-hill" belt, which often separates the remainder of the Coastal Plain from the Piedmont Province or from other adjacent inland territory.

LIMITATIONS IN USE.

Because of its coarse texture and open, incoherent structure, the Norfolk sand is not usually well suited to the production of the great staple crops grown in general farming. The prevalent lack of organic matter in the surface soil and the free drainage in both surface soil and subsoil tend to make this soil type too droughty during the latter part of the growing season, especially in mid-summer. In consequence, the long-growing crops, which require large amounts of soil moisture for their nourishment at this period, are usually seriously affected and fail to produce satisfactory yields. Corn, oats, wheat, grass, and even cotton can not be produced advantageously upon the Norfolk sand.

The same textural characteristics and the same lack of organic matter over considerable areas, while adverse to the practices of general farming, tend to constitute in the Norfolk sand practically open-air greenhouse conditions which are particularly favorable to the early tillage of the soil, the early planting of the crop and the forcing to maturity of special products grown for trucking purposes. These vegetables may be planted upon the Norfolk sand at a date considerably earlier than upon any other soil type associated with it in the trucking regions extending from New Jersey southward to eastern North Carolina. Within this region the Norfolk sand is thoroughly appreciated and largely occupied for the production of early truck crops. The soil absorbs the spring rains rapidly. The soil moisture is readily drained downward, and the land, even immediately after heavy rainfall, is soon in good condition for tillage operations. As a result vegetables may be planted early and at the latter end of the season, they mature their yield from 1 week to 10 days earlier than upon any other soil type in the same general region. Since the profit to be derived from the production of truck crops arises largely from placing them upon the market at the earliest possible moment, the Norfolk sand stands preeminent among all of the soils of the northern Atlantic Coastal Plain for the production of extra early truck crops.

The practically level surface of the Norfolk sand, its freedom from any serious erosion, and the location of the soil within those regions

which are well served by rail and water transportation, give it an added value for the production of the market-garden crops.

As a result the Norfolk sand may be characterized as *the most valuable of the early trucking soils* from New Jersey to the southern limit of North Carolina. Even in more southern regions where the extreme early maturity of the crop is not so great an advantage, the Norfolk sand still constitutes a valuable truck soil. The type is a special-purpose soil rather than one suited to general farming.

IMPROVEMENT IN SOIL EFFICIENCY.

There is probably no single improvement in the efficiency of the Norfolk sand which would equal that of the incorporation of a sufficient amount of organic matter in the surface soil to render it somewhat more retentive of moisture and less liable to drought during the summer. The soil is so loose and open that to a depth of 6 or 8 inches it is thoroughly aerated and subject to all of those processes of oxidation which tend to destroy any organic matter which may be incorporated with it. Even under natural conditions and before it is occupied for cultivation the tendency has been toward the destruction of such organic matter as might naturally be incorporated with a virgin soil. Especially under intensive cultivation is there a strong tendency toward a loss of humus. Nearly all of the processes of cultivation give rise to greater aeration than is normal in the natural soil and therefore tend toward the destruction of organic matter. In consequence the trucker or the general farmer upon the Norfolk sand who would maintain the productivity of his soil must take constant care of it. It is not sufficient to depend upon commercial fertilizers, either the general or special brands, for the maintenance of soil fertility or productivity upon this soil. Practically no increase in the crop yields may be permanently obtained, and in many cases the normal crop yield may not be secured through any long period of years unless a strenuous effort is made toward the incorporation of organic matter in the surface soil each year. For this purpose a green manuring crop grown during the winter months, to be plowed under prior to the planting of the spring truck crop, is highly recommended.

For such purposes several crops are grown in the Coastal Plain section. In all of the more northern regions crimson clover has been used extensively and with very satisfactory results. In the same general region and southward cowpeas, sown either between the rows of the intertilled crop at a time when it has nearly reached maturity or broadcast over the entire area of the field, constitute a very valuable green manuring crop. In more southern locations crops of hairy vetch and of velvet beans may also be grown during the winter

months for the purpose of being plowed under to restore and maintain organic matter. Wherever this method of treatment is undertaken, it is advisable, immediately after plowing under the crop, to apply slaked quicklime to the surface soil to the extent of 1,500 or 2,000 pounds per acre. This is essential in order to promote the complete and thorough disintegration and decomposition of the organic matter incorporated with the soil, lest at a later date the roots of a succeeding crop should penetrate to an undecomposed mass of green and sour organic matter. The presence of the lime hastens the complete decomposition of the organic matter and its rapid incorporation with the surface soil. The lime should be applied to the soil at least 10 days or 2 weeks before the succeeding crop is planted and thoroughly harrowed in to a depth of 2 or 3 inches.

There are several other crops which are available for green manuring purposes, but they are not so valuable as the leguminous crops already mentioned. These additional crops are winter wheat, winter rye, or winter oats. There are circumstances under which each may be used to advantage.

In the trucking areas located near the northern cities it is frequently possible for the truck farmer to secure large quantities of stable manure from city livery stables and from other sources. Under such conditions the stable manure is applied in large quantities as a top dressing, to be plowed and harrowed into the surface soil. While this method of restoring organic matter is sometimes rather expensive, it is undoubtedly the most effective way to maintain the producing power of the Norfolk sand. In more southern locations it is frequently possible and desirable to apply cotton-seed meal at the rate of 500 pounds per acre or more to constitute a nitrogenous organic manure used to supplement the commercial fertilizers which are employed to force the growth of the truck crop.

This matter of restoring and maintaining organic material within the surface soil of the Norfolk sand is one of the most important improvements of the efficiency of this soil.

Even after the organic matter content of the Norfolk sand has been increased to a desirable amount, it is frequently necessary to adopt certain methods of tillage particularly applicable to the maintenance of a moisture supply in such a coarse and open-textured soil. It has been found through long years of experience by the best truck growers and by a large number of farmers that those methods of tillage must be adopted which frequently stir the surface soil to a shallow depth. This gives rise to the formation of a thoroughly dried surface layer, or "dust mulch," which interposes a blanket of dry material between the evaporation processes of the atmosphere above and the moisture content of the soil below. This practice, particularly in the case of the intertilled crops, produces excellent results

in maintaining the soil moisture supply essential for the production of large yields per acre. Deep plowing upon the Norfolk sand is not generally to be recommended as it tends to break up any compactness in the structure of the subsoil and lessens its moisture-holding capacity.

It would be impossible in the case of such highly specialized crops as those which are produced upon the truck farms and especially under varying conditions of previous treatment of the soil, of attendant climatic surroundings, and of presence or absence of an adequate organic matter supply in the surface soil, to recommend any particular fertilizers for use upon the Norfolk sand. In general it may be said that in the trucking areas a sufficient amount of experimentation has been conducted by the individual trucker so that each one knows, within general limits, the kinds of fertilizers which will be of the greatest value to him in the production of certain crops.

There are a few general principles which may be modified to meet local conditions under different circumstances of previous soil treatment, of the class of crops to be grown, and of the methods of tillage to be adopted. In the production of such crops as spinach, cabbage, and lettuce it is frequently a good practice to lime the soil heavily before the crop is to be grown. The form which this application is to take depends largely upon the cost of the different forms of lime in the different localities where it is to be used. Burned stone lime or lump lime, which may be secured either by the barrel or in carload lots, is the most effective for agricultural purposes. This material must first be slaked and then when finely powdered, it must be evenly distributed over the surface of the land and incorporated by harrowing to the depth of 2 or 3 inches in the surface soil. Some economy in the use of lime is secured through its purchase in this form, as it contains no extraneous materials such as water or carbon dioxide to add to its bulk.

EXTENT OF OCCUPATION.

There is a wide variation in the degree to which the Norfolk sand is occupied for agricultural purposes in the different districts where it occurs. Wherever there is adequate transportation to the northern markets, practically all of the favorably situated areas of the Norfolk sand in New Jersey, Delaware, Maryland, and eastern North Carolina have been used for the production of extra early vegetable crops. Throughout all of this general region it is interesting to note that the truckers have learned the adaptations of this type to such a degree that in a single field under tillage to truck crops there will be a careful selection of those crops suited to the warm, loose, porous, early Norfolk sand as distinguished from crops which are habitually planted upon the finer sandy soils, or upon the associated sandy loams and silt loams.

In other sections of the Atlantic and Gulf coast region it can not be said that the Norfolk sand is so thoroughly utilized for those special purposes to which it may best be put. Even where transportation facilities are fairly adequate in the South Atlantic section, and particularly in the Gulf Section, there still remain large areas of the Norfolk sand which are grown up to a scraggly growth of scrub pine or which are old fields not used permanently for any agricultural purpose.

This arises from two causes: First of all, in the more southern latitude, other varieties of soil, particularly the Norfolk fine sand, are capable of producing the special crops at a date sufficiently early to allow of competition with the areas of the Norfolk sand of more northern latitudes. Secondly, these finer grained soils retain more moisture, and for this reason produce somewhat larger yields than the Norfolk sand. In consequence the trucker in the more southern latitude selects the finer textured soil and produces not only a crop sufficiently early to meet the market demands, but also secures a larger yield usually at somewhat less expense than is the case upon the Norfolk sand areas. For this reason, it is in the more northern regions, from the vicinity of Cape Hatteras to the latitude of Long Island, that the Norfolk sand has been particularly sought out and most completely developed for the special purpose of producing extra early market garden and truck crops.

There still remain hundreds of thousands of acres of the Norfolk sand from Cape Hatteras southward along the Atlantic coast and westward throughout the Gulf States which give only small yields of the general farm crops or are not cultivated at all. There is, therefore, an almost unlimited opportunity for the extension of the production of extra early truck crops upon the Norfolk sand, and this opportunity occurs in the more southern latitudes where increasingly early yields may be secured.

The principal drawback to the cultivation of the Norfolk sand has been a limited market for its special product. As the northern cities grow and increase their demand for early fresh vegetables there will be undoubtedly an extension of the occupation of the Norfolk sand for the production of those crops to which it is peculiarly suited. It is probable that only the Orangeburg sand of the same general region will ever be able to compete with the Norfolk sand as an extra early trucking soil.

CROP ADAPTATIONS.

General farm crops.—Since the Norfolk sand occurs in areas which are widely separated geographically and which lie under decidedly different attendant conditions of climate, there is a considerable variation in the classes of general farm crops which are produced to

best advantage upon the type. In all of the regions from Long Island southward to Cape Hatteras, in what may be termed the North Atlantic section, the Norfolk sand is universally used for the production of corn. The yields of corn as a field or grain crop are universally low. It is only upon those fields where the owners have systematically produced winter cover crops, particularly the crimson clover, to be plowed under as green manure, that anything like satisfactory yields are secured. Even under the conditions of best preparation and most perfect tillage, the yields rarely rise above 35 to 40 bushels per acre and yields of such magnitude are decidedly unusual. Upon fields less well prepared, and within which less attention has been paid to the maintenance of organic matter in the surface soil, the yields decline to 20 bushels per acre for a general average in the North Atlantic States, and are even as low as 10 bushels per acre in seasons of unusual drought. South of Cape Hatteras corn is only produced to a limited extent upon the Norfolk sand. Yields ranging from 5 to 15 bushels per acre, with an average of from 8 to 10 bushels, are too low to justify the production of this crop upon this type of soil.

Some attempts are made in the more northern States to produce other general crops upon the Norfolk sand. Oats are sometimes seeded as a summer grain, giving yields which range from 18 to 25 bushels per acre, with a small growth of straw. Rye is grown as practically the only winter grain, giving small yields. Occasionally the farmer attempts a seeding to some of the grasses. Wherever reasonable success is attained in such seeding, low yields of hay ranging from three-fourths of a ton to 1 ton per acre are secured. Of course under peculiarly favorable circumstances or with exceptionally good tillage these yields are exceeded. However, the yields of all general farm crops are so low that the Norfolk sand is only tilled for the purpose of their production when it occurs in small areas associated with other more valuable general farming soils at points so remote from transportation that the production of truck crops is not possible or in locations where the knowledge of the production of such crops is not general.

In the more southern States cotton is grown upon the Norfolk sand to a considerable extent. The type is not particularly chosen for this purpose, but where areas of it occur upon the farm it is planted, like practically all of the other soils of the Atlantic and Gulf coast regions, to this crop. The yields are universally low, ranging from one-fourth to two-fifths bale per acre. It is only under unusual circumstances of low-lying position or an extra amount of organic matter in the surface soil that these yields are ever exceeded.

Consequently the occupation of the Norfolk sand as a cotton soil may not be recommended. Winter oats are also sown upon this type to a limited degree in the more southern States. Some attempt at the production of peanuts upon the type has been made in eastern Virginia and in eastern North Carolina, but with rather unsatisfactory results so far as yields are concerned. Only when the type is heavily limed can a satisfactory growth of peanuts be secured. The bright cigarette tobacco is also raised to a considerable extent upon the Norfolk sand in some sections of eastern North Carolina, but the Norfolk fine sand, the Norfolk sandy loam, and Norfolk fine sandy loam are all of them to be preferred for the production of this crop. The shade-grown wrapper tobacco of the Florida-Georgia region may also be grown upon the Norfolk sand, but only to a satisfactory yield when irrigation is practiced. Consequently the general farm crops are produced to a limited extent only upon the Norfolk sand, and for this reason considerable areas of the type have remained uncultivated in all of the regions where the trucking industry has not yet been established.

Truck crops.—By contrast, the Norfolk sand stands out preeminently as the trucking soil of the North Atlantic coast region and as a strong competitor of all other types of soil, even in the more southern localities where trucking is practiced. A wide variety of vegetable and fruit crops is raised upon the Norfolk sand. It is probable that for the production of early asparagus there is no soil in the North Atlantic coast region which can compete with the Norfolk sand. The well-known localities for asparagus growing on western Long Island, in central New Jersey, eastern Virginia, and even in eastern North Carolina, all produce the earlier crops upon the Norfolk sand. Even in other localities where asparagus is produced, soil conditions which approach closely to those afforded by the Norfolk sand are usually selected for the cultivation of the crop. The extension of asparagus culture upon the Norfolk sand should be advocated.

Similarly the Norfolk sand is the chosen watermelon soil of the North Atlantic Coastal Plain. From New Jersey to Georgia the earliest and sweetest melons are produced upon this type. The yields are good and the quality is unsurpassed. The Norfolk sand is second only to the Norfolk fine sand in growing cantaloupes where both soils occur. In all other areas the Norfolk sand is easily first as a cantaloupe soil. The type produces early melons of good quality in all of the North Atlantic trucking regions, and it has also been used for the production of this crop in Florida and in Texas. Those truckers who desire to secure extra early melons usually plant the hills of melons in old tin cans or in berry boxes and when the melons have made some growth under greenhouse conditions or in the hotbed the entire hill is transplanted into the fields without disturbing the

roots, giving an advantage of from 1 week to 10 days in the date of maturity of the crop thus planted over the general field crops. Of course, only small areas may thus be treated, but those truckers who take a particular pride in placing the first melons from their district upon the early market frequently adopt this method for securing extra early maturity.

The Norfolk sand has practically made the reputation of the State of New Jersey for the production of sweet potatoes. Large areas of this crop are annually planted in the south central and southwestern counties of the State upon this type of soil. Not only are the yields satisfactory, but the potatoes themselves are sweet and of a fine, mealy texture, such as is demanded by the northern consumer. It is probable also that sweet-potato cultivation for the northern market could well be extended throughout eastern Virginia, eastern North Carolina, and even into eastern South Carolina by utilizing the Norfolk sand. The northern market demands a dry, mealy potato which is not usually appreciated by the southern growers. In consequence the selection of the Norfolk sand for the planting of particular varieties, especially the red varieties of sweet potatoes, should be followed in the more southern region.

The Norfolk sand is also used for the production of the extra early Irish potatoes which make their appearance on the northern market in the early months of spring. The yields per acre of these potatoes are not particularly high, ranging around 100 bushels per acre. The earliest shipments from the region between Savannah, Ga., and Norfolk, Va., secure the highest market prices. In the case of this crop it is also possible in most of the southern locations to produce some other later season truck crops following the removal of the potatoes, or—and this practice is frequently to be preferred—to produce some leguminous forage crop or cover crop for the feeding of the work stock or for incorporation in the soil to maintain or restore organic matter.

The Norfolk sand is also used from Florida northward along the Atlantic coast for the production of extra early English peas as a truck crop and to a limited extent for their production for the canning factory. Snap beans are also produced for the early market in Florida, Georgia, and the North Carolina trucking districts. Both of these crops mature at a very early date and receive the highest prices for shipments to northern markets. Some of the truckers practice the extremely intensive system of securing a crop of peas or beans at a very early date from the Norfolk sand. Before either crop is harvested they plant, immediately adjoining the rows of peas or beans, hills of cucumbers, which at a slightly later date will mature an extra early crop for market. The yields of cucumbers are not particularly high, and the soil is not peculiarly suited to the produc-

tion of this crop. However, its production in conjunction with peas and beans is coming to be an established practice, particularly in eastern North Carolina and Virginia.

Tomatoes are produced upon this soil only for market-garden purposes. The early varieties are planted and shipped in baskets to the city market. For the canning crops, other finer textured soils are, and should be, selected.

Cucumbers, lettuce, and eggplant are somewhat unusual crops upon the Norfolk sand, since they produce larger yields and a better quality upon the finer grained soils usually found associated with it in the majority of trucking districts.

Among the small-fruit crops the early varieties of strawberries are most extensively grown upon the Norfolk sand. This type of soil produces the earliest berries which find their way to the northern market, and, while the yields are not particularly high, still the higher prices secured for early berries warrant the extension of strawberry cultivation upon the type. Dewberries and blackberries may also be produced to advantage upon the Norfolk sand where the market for these exist, and where a particularly early crop is desired.

Among the tree fruits peaches are the only ones which may be grown to any advantage upon the Norfolk sand, and the planting of peach orchards upon this type may only be advocated in the North Atlantic States. The life of the trees is usually short, but the quality and color of the fruit are exceptionally fine. For box shipments of peaches in small-sized carriers, the Norfolk sand probably excels any other soil of the North Atlantic coastal region.

In more southern localities some pecan orchards have been planted upon the Norfolk sand. None of these have attained to such maturity that the value of the soil for pecan production can be estimated. In general other soil types of the section, particularly the Norfolk sandy loam and the Norfolk fine sandy loam, are rather better suited to the production of this crop.

Cover crops for green manuring.—One of the great problems of the trucker or market gardener is to secure an adequate supply of organic matter for the maintenance of the producing capacity of his soil. Wherever city supplies of stable manure may be secured, this method is usually employed. It is attended, however, by considerable expense. The methods employed by the trucker are such that he is forcing his crop to the earliest possible maturity, and frequently the land upon which the vegetables are produced is free from any market crops by the month of June. In the majority of areas this leaves a considerable growing period during which either later season truck crops may be produced or some valuable forage or cover crop may occupy the land.

In all of the more northern areas where the Norfolk sand is chiefly utilized for the production of truck crops, it is essential that winter cover crops such as crimson clover or rye should be grown between seasons. These crops should be turned under at an early date in the spring in order to furnish a renewed source for organic matter in the surface soil. In the use of such crops it is frequently desirable that after the turning under of the green manuring crop, burned stone lime should be applied at the rate of 1,500 to 2,000 pounds per acre in order to promote the decomposition of the green manure.

In the Middle Atlantic States from Virginia southward crimson clover may be used as the winter green manuring crop or cover crop, and in addition the winter or hairy vetch is well suited to this latitude and soil for the purpose mentioned. Winter rye or winter oats may be used among the nonleguminous crops. It is usually a good practice in this section to produce a crop of cowpeas where possible, which may be sown upon the land used for the production of the earlier truck crops and freed from those crops during the early portion of the summer. The cowpeas will come to a sufficient degree of maturity to furnish a large amount of valuable green manure if turned under in time for the preparation of the land for the truck crops in the succeeding spring. Farther south the velvet beans and bur clover are as valuable as the cowpeas for such purposes. Thus, under different climatic conditions and under different conditions of tillage of the Norfolk sand, a variety of crops which either grow during the latter part of the summer or early fall or even during the winter may be produced for the sole purpose of being turned under for the maintenance and restoration of organic matter. A greater degree of attention to this care of the soil will always result in increased crop yields upon the part of the succeeding market crop and the permanent increase of the crop producing capacity of the soil itself.

FARM EQUIPMENT.

The tools and equipment used for the cultivation of the Norfolk sand vary decidedly in the different districts where the type is developed. In all of the trucking regions the areas cultivated by the single owner or tenant are small. In consequence the 1-horse hitch and small tools for intensive cultivation are most commonly employed. Farther to the south where the Norfolk sand is used to some extent for the production of corn and cotton the prevailing 1-horse or 1-mule hitch and the light-weight general-farming tools are also employed. In almost all instances these tools are adequate for moving and stirring sufficiently the mellow, incoherent surface soil. They are certainly adequate for the later cultivation of the type unless large areas of a single crop like corn are included in the farming system.

The equipment of the type with respect to buildings varies considerably in the different portions of the sections where the type is developed. In the trucking region not only are the ordinary farm-houses and barns for the storing of produce and for the shelter of the work stock maintained in good condition, but there are also usually packing houses for the accommodation of the workers who are preparing the fruit or truck crops for shipment to market. Thus the more intensively farmed portions of the Norfolk sand have ample equipment well suited to the needs of the soil and to the methods of farming which are adopted. In the more southern regions, in the cotton-growing section, the equipment of buildings is usually meager, and in some cases inadequate to the proper operations of those farms which include a large proportion of Norfolk sand. This arises largely from the low yields obtained upon this type in cotton and corn production and the consequent inability to equip the farms properly for the shelter of the tenant or of the work stock. In general, it may be said that the adequacy of the equipment depends more largely upon the class of farming adopted for this type than upon any other factor. The profits which accrue from intensive farming are most frequently invested in improvements of equipment, particularly of work stock and of tools, to increase the yield and lower the cost of production.

SUMMARY.

The Norfolk sand is an extensive type of soil occurring along the Atlantic and Gulf coasts from New Jersey to Texas.

The type is characterized by a gray or pale-yellow surface sandy soil having a depth of 6 to 8 inches in the majority of cases. This is underlain by a yellow, or slightly reddish-yellow, or, occasionally, orange, sand subsoil, which extends to a depth of 3 feet or more.

The surface of the Norfolk sand is usually nearly level or else undulating to gently rolling in its surface features. It is well drained, free from swamps, and, in the majority of instances, the character of the soil and the gentle slopes within its area prevent any serious erosion of the type.

The Norfolk sand, because of its coarse texture and slight retentive properties, is unable to maintain a moisture supply sufficient to produce large crops of the cereals and staple fiber crops of the regions within which it occurs.

By contrast the type, on account of the same properties, is light, loose, easily worked, warm, and early. Therefore, its best use, wherever transportation facilities are adequate, is for the production of those extra early market-garden and trucking crops which derive their greatest value from being placed upon the market in advance of the crop from any other type of soil.

Of the staple crops, corn and cotton are most universally raised upon the Norfolk sand in all of the areas where the climatic conditions are favorable to their production. Oats are raised to a limited degree as a summer crop in the more northern areas and as a winter crop in the more southern ones. To a limited extent, peanuts, bright tobacco, and even wrapper tobacco are grown in different localities upon the Norfolk sand. The yields are usually low, and the soil type can not be recommended for the general production of these crops.

Among the truck crops, the extra early asparagus is probably the best suited of any to the Norfolk sand and is the most profitable. It is also the chosen soil for the production of sweet potatoes, watermelons, cantaloupes, and the extra early Irish potatoes in all of the North Atlantic and Middle Atlantic trucking regions. It is fairly well suited to the production of extra early peas and beans for market-garden purposes and for truck shipment. Tomatoes, cucumbers, eggplant, lettuce, and a few minor trucking crops are also raised to a limited degree. Among fruit crops, the peach is the only tree fruit which may be recommended for production upon the Norfolk sand. To a limited extent pecans have been planted upon this type in the Middle Gulf section.

The equipment of the Norfolk sand with buildings and with implements varies according to the uses to which the type is put and with the degree of agricultural development and prosperity of the section within which it occurs. In general, only the lighter work stock and the lighter implements are found necessary for the cultivation and management of this loose incoherent soil.

For the improvement of crop yields upon the Norfolk sand probably the greatest benefit may be derived from the incorporation of added amounts of organic matter in the surface soil. For this purpose the winter cover crops, such as crimson clover and rye in the more northern States; cowpeas, crimson clover, winter vetch, winter rye, and winter oats in the Middle Atlantic States; and the velvet bean, bur clover, winter rye, or winter oats in the more southern locations may best be used. Wherever possible the leguminous crops should be employed for this purpose. It is frequently desirable after plowing under a heavy green manuring crop to apply lime to the extent of 1,500 to 2,000 pounds per acre in order to promote the rapid decomposition of the organic matter within the soil.

Where stable manure is available from city sources it is extensively used for increasing the crop-producing power of the Norfolk sand, particularly in the trucking region.

Where transportation to Northern markets is available the price of the Norfolk sand has risen to \$150 or even \$250 an acre where

used for trucking. In other regions more remote from transportation or less favorably situated with regard to climatic environment, large tracts of the type may be bought at from \$3 to \$5 an acre, since the type is not usually recognized as of any high value for general farming purposes. In consequence large areas still remain unoccupied and uncultivated. As the demand for additional supplies of extra early vegetables increases with the increased growth of the northern cities, there will still be found extensive areas of the Norfolk sand well suited to meet this demand.

The Norfolk sand must thus be characterized as a special-purpose early trucking or early market-garden soil, and this will probably remain its chief function until different methods of tillage and possibly different staple crops may have been introduced into the region where it is chiefly found.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., August 11, 1911.

APPENDIX.

The following table shows the extent of the Norfolk sand in the areas surveyed to this time. In the first column is stated the particular survey in which the soil was encountered; in the second column, its extent in acres; and in the third column, the volume of the Field Operations of the Bureau of Soils in which the report upon the area may be found. Those desiring a detailed description of the soil and of the general conditions which surround it in any particular area may consult these volumes in almost any public library.

Areas of Norfolk sand encountered in the soil survey.

Survey.	Area of soil.	Year of publication, Field Operations.	Survey.	Area of soil.	Year of publication, Field Operations.
Alabama:			Maryland:		
Baldwin County.....	190,784	1909	Anne Arundel County.....	25,024	1909
Butler County.....	20,544	1907	Calvert County.....	58,000	1900
Coffee County.....	102,016	1909	Prince George County.....	23,630	1901
Dallas County.....	7,168	1905	Worcester County.....	45,312	1903
Henry County.....	128,768	1908	Mississippi:		
Lee County.....	8,704	1906	Biloxi area.....	76,032	1904
Macon County.....	22,016	1904	Jasper County.....	1,536	1907
Mobile area.....	134,592	1903	Scranton area.....	11,392	1909
Montgomery County.....	4,288	1905	New Jersey:		
Sumter County.....	15,296	1904	Trenton area.....	50,880	1902
Delaware:			North Carolina:		
Dover area	5,632	1903	Edgecombe County.....	16,192	1907
Florida:			New Hanover County.....	19,456	1906
Escambia County.....	191,744	1906	Pitt County.....	35,520	1904
Gadsden County.....	93,120	1903	Raleigh to Newbern area.....	53,312	1900
Gainesville area.....	139,328	1904	Robeson County.....	51,648	1908
Jefferson County.....	105,856	1907	South Carolina:		
Leon County.....	106,688	1905	Charleston area.....	1,088	1904
Marianna area.....	81,856	1909	Conway area.....	24,960	1909
Georgia:			Darlington area.....	71,104	1902
Bainbridge area.....	19,456	1904	Lancaster County.....	38,528	1904
Dodge County.....	175,296	1904	Lee County.....	27,904	1907
Fort Valley area.....	33,792	1903	Orangeburg area.....	86,080	1904
Grady County.....	6,528	1908	Saluda County.....	512	1909
Hancock County.....	37,632	1909	Sumter County.....	32,064	1907
Thomas County.....	5,504	1908	Texas:		
Tift County.....	6,400	1909	Anderson County.....	55,808	1904
Waycross area.....	27,904	1906	Houston County.....	4,544	1905
Louisiana:			Robertson County.....	3,456	1907
Bienville Parish.....	32,256	1908	San Antonio area.....	3,904	1904
Tangipahoa Parish.....	896	1905	Willis area.....	8,560	1901
Winn Parish.....	704	1907	Virginia:		
			Chesterfield County.....	11,200	1906



